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SAND AND GRAVEL WASTE EVALUATION STUDY, SOUTH PLATTE RIVER BASIN, COLORADO

Federal Water Pollution Control Administration
Denver, Colorado

May 1968

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SAND AND GRAVEL

WASTE EVALUATION STUDY

SOUTH PLATTE RIVER BASIN, COLORADO

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A limited study of sand and gravel companies located in the South Platte River Basin was undertaken at various times throughout 1965 and 1966. The broad objectives [redacted] were to determine the location and type of gravel operations; industrial procedures employed; degree of treatment and means of disposal of liquid wastes from these establishments; and to assess the general pollution problems & remedial measures indicated as necessary by the industry.

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FORWARD

This report represents one in a series of working documents prepared by the South Platte River Basin Project for the purpose of recognizing certain information not previously published by the Project. This particular report gives representative data and findings and conclusions developed from a waste evaluation study on sand and gravel washing operations during 1965-1966. The two other reports in this series describe the mining and outdoor recreation industries in the South Platte River Basin. These activities are important to both the enforcement and long-range efforts of the Federal Water Pollution Control Administration assisting in the planning for water management and control and abatement of pollution in the South Platte River Basin and the Missouri River Basin.

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INTRODUCTION AND BACKGROUND

Sand and gravel quarrying operations represent an important commercial enterprise in the State of Colorado and particularly within the Denver Metropolitan Area. The significance of this industry is reflected in a cumulative value of $195 million for sand and gravel produced over the years through 1965, giving it first ranking among all non-metallic minerals mined in the State. Currently, sand and gravel is one of the fastest growing areas in both metallic and non-metallic mineral production. Its annual value output in 1965 was $22.7 million, ranking second only to molybdenum (1,2).

Sand and gravel reserves in the Denver area are estimated around 200 million tons but one-half or approximately 100 million tons are deposited in the area to be inundated by the Chatfield Reservoir (now under construction). To counter this problem, the Colorado State Senate has approved a memorial asking the U. S. Congress to permit continued extraction of sand and gravel in the Chatfield area, and in this connection, planned recreational facilities around Chatfield Reservoir may be deferred accordingly. Without the Chatfield reserves, sand and gravel in the Denver area are estimated to yield only a 10-year supply for the Denver Metropolitan Area (3,4,5,6,7).

Dredging of sand and gravel from stream bottoms and natural lakes is practiced extensively throughout the United States. Dredging can cause complete upheaval of the stream bottom bringing large quantities of sediment into suspension. Suspended sediment may completely destroy

aquatic flora and fauna by reducing transmission of light necessary for aquatic life, and absorbing organic matter creating unfavorable bottom conditions. Many sand and gravel operations are instrumental in widening of stream channels and changing the nature of the stream bottom to shifting silts and sands whereby fish spawning sites are buried and smothered. Also, these effects are frequently detrimental to downstream municipal and industrial water supplies (8,9).

A limited study of sand and gravel companies located in the South Platte River Basin was undertaken at various times throughout 1965 and 1966. The broad objectives of this study were to determine the location and type of gravel operations; industrial procedures employed; degree of treatment and means of disposing of liquid wastes from these establishments; and to assess the general pollution problems and remedial measures indicated as necessary for the industry. The study showed that sand and gravel reserves over the South Platte River Basin are currently being extracted at the rate of 9 - 10 million tons yearly, and of this amount 75 percent is mined in the Denver Metropolitan Area. The industry in 1966 was represented by a total of 57 sand and gravel facilities of which 29 were situated in the Denver Metropolitan Area and 28 over the remainder of the Basin.

DESCRIPTION AND LOCATION

Sand and gravel may be produced using either dry or wet handling procedures. A dry operation is associated with facilities extracting (dredging, mining) sand and gravel. A wet operation additionally includes the equipment and procedures necessary for the washing of sand and gravel. Washing removes the extraneous or unwanted waste material from the salable product. Wet operations may consist of a closed-circuit wash system or otherwise there is waste discharge to a receiving stream or body of water. The waste effluents, in turn, may or may not receive adequate treatment prior to discharge.

Of the 57 sand and gravel establishments dispersed over the Basin, 3 were inoperative at the time of field visits and consequently no information was obtained on the latter facilities. The remaining 54 establishments consisted of 15 plants with dry operations and 39 plants providing for washing of aggregates. The 39 wet operations, in turn, were classified as follows: 18 plants having closed-circuit wash systems and no waste discharge to a Basin stream; 12 plants providing limited treatment of their waste effluents; and 9 plants without any treatment for their waste effluents.

Based upon limited information received in the field, it was judged that plants producing a few hundred tons of aggregate daily could be classed as small to medium-sized; plants having a daily output between 10-15 hundred tons aggregate could be described as medium to large-sized; and those exceeding 1500 tons daily, could most likely be described as very large relative to the industry in the South Platte River Basin.

The name, type of operation and location of the 57 sand and gravel companies located in the South Platte River Basin are given in Tables I and II and Figures 1-3. Table I lists the plants in the Denver Metropolitan Area, and Table II those in the remainder of the Basin. Figures 1, 2 and 3 show the map locations of the various plants together with the receiving streams, respectively within the Denver Metropolitan Area, and the Middle and Lower portions of the Basin.

TABLE I

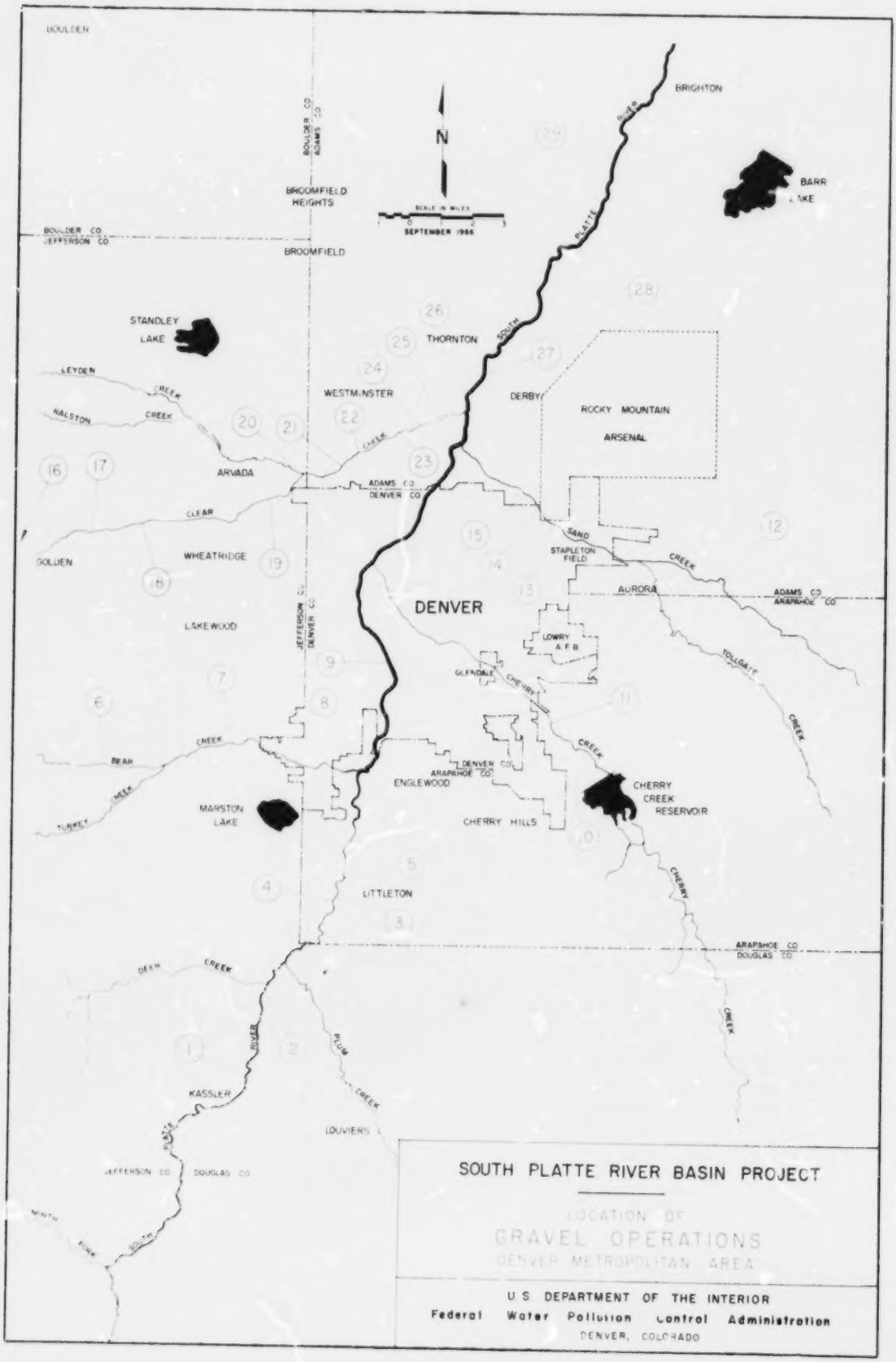
LOCATION OF SAND AND GRAVEL OPERATIONS
DENVER METROPOLITAN AREA

Map No.	Name	Type of Operation
1	Colorado Pre-Mix Co.	Mining and washing
2	Hall Sand & Gravel Co.	Mining and washing
3	Cooley Gravel Co.	Mining and washing
4	Peter Kiewit Co.	Mining
5	Central Construction Co.	Dredging
6	Bear Valley Gravel Co.	Mining and washing
7	Morrison Redi-Mix Concrete Co.	Dredging and washing
8	Herbertson Sand and Gravel Co.	Mining and washing
9	Winslow Construction Co.	Dredging
10	Seip Bros. Sand Co.	Mining and washing
11	Mobile Concrete, Inc.	Mining
12	Empire Sand & Gravel Co.	Mining and washing
13	Lester Jones Sand & Gravel Co.	Mining and washing
14	Superior Sand & Gravel Co.	Mining and washing
15	Jones Fine Sand Co.	Mining and washing
16	Empire Sand & Gravel Co.	Mining and washing
17	Rio Grande Gravel Co.	Mining and washing
18	Jefferson Transit Mix Co.	Mining and washing
19	Arvada Redi-Mix Co.	Not operating
20	Suburban Redi-Mix Co.	Mining and washing
21	Cooley Gravel Co.	Mining and washing
22	Brannan Sand & Gravel Co. (Pit No. 10)	Not operating
23	Brannan Sand & Gravel Co. (Pit R)	Mining and washing
24	Western Paving & Construction Co.	Mining and washing
25	Hubner Construction Co.	Mining
26	Brannan Sand & Gravel Co. (Pit No. 1)	Mining and washing
27	Boise Cascade Gravel Co.	Mining and washing
28	Commercial Sand & Gravel Co.	Mining and washing
29	Adams Transit-Mix Co.	Mining and washing

TABLE II

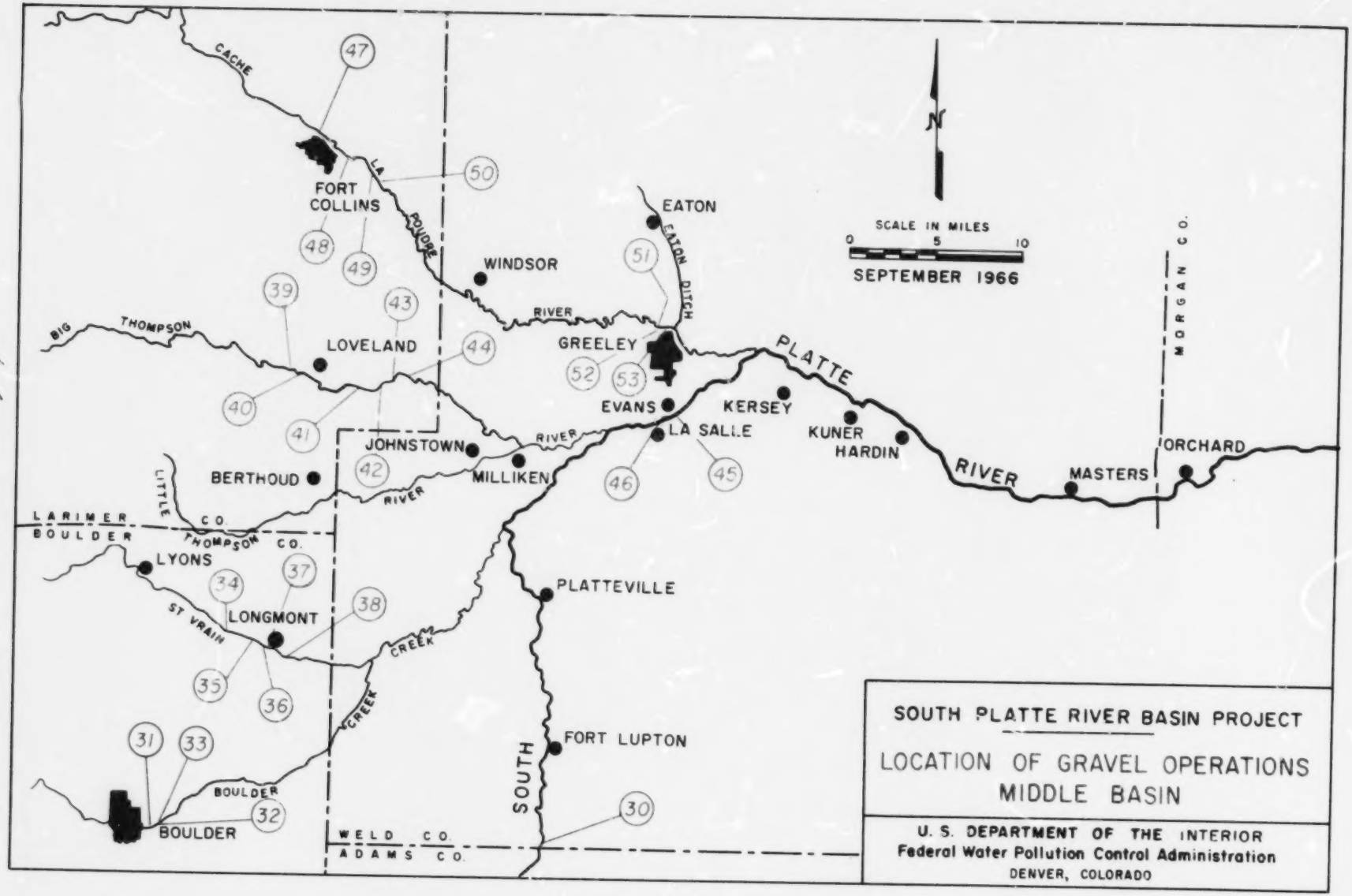
LOCATION OF SAND AND GRAVEL OPERATIONS
REMAINDER OF BASIN

Map No.	Name	Type of Operation
30	Platte Valley Concrete Co.	Mining and washing
31	Boulder Redi-Mix Co.	Mining
32	Flatiron Sand & Gravel Co.	Mining and washing
33	Western Paving Co.	Mining and washing
34	Martenson Sand & Gravel Co.	Mining
35	Martenson Sand & Gravel Co. (Washing Pit)	Washing
36	Flatiron Sand & Gravel Co.	Mining
37	Longmont Redi-Mix Co.	Mining
38	Golden Gravel Co.	Mining and washing
39	Jess Johnson Co.	Mining
40	Loveland Redi-Mix Co.	Mining and washing
41	Flatiron Materials Co.	Mining
42	Schaffer Sand & Gravel Co.	Mining
43	Floyd Haag Sand & Gravel Co.	Mining and washing
44	Flatiron Paving Co.	Mining
45	Moffat & Son Co.	Mining and washing
46	Torrez Sand & Gravel Co.	Mining and washing
47	Sterling Sand & Gravel Co.	Mining and washing
48	Fort Collins Redi-Mix Co.	Mining and washing
49	Flatiron Sand & Gravel Co.	Mining and washing
50	Schultz & Lindsay Co.	Mining
51	Flatiron Paving Co.	Mining
52	Greeley Sand & Gravel Co.	Mining and washing
53	Herran & Strong Co.	Not operating
54	(name unknown)	Mining and washing
55	Builders Aggregate Co.	Mining and washing
56	Green Brothers Co.	Mining and washing
57	Sterling Redi-Mix Co.	Mining and washing


BOULDER
BRIGHTON
BOULDER CO
ADAMS CO
BROOMFIELD HEIGHTS
N
SCALE IN MILES
SEPTEMBER 1966
BOULDER CO
JEFFERSON CO
BROOMFIELD
BARR LAKE
STANDLEY LAKE
THORNTON
SOUTH PLATTE
LEYDEN CREEK
HALSTON CREEK
WESTMINSTER
DERBY
ROCKY MOUNTAIN ARSENAL
ARVADA
ADAMS CO
DENVER CO
CLEAR CREEK
SAND CREEK
STAPLETON FIELD
GOLDEN
WHEATRIDGE
AURORA
ADAMS CO
ARAPAHOE CO
DENVER
LAKEWOOD
JEFFERSON CO
DENVER CO
LOWRY A.F.B.
GLENDALE
CHERRY CREEK
TOLLGATE CREEK
BEAR CREEK
TURKEY CREEK
DENVER CO
ARAPAHOE CO
ENGLEWOOD
CHERRY CREEK RESERVOIR
MARSTON LAKE
CHERRY HILLS
CHERRY CREEK
LITTLETON
ARAPAHOE CO
DOUGLAS CO
DEER CREEK
PLUM CREEK
SOUTH PLATTE RIVER
KASSLER
LOUVIERS
JEFFERSON CO
DOUGLAS CO
SOUTH PLATTE RIVER
SOUTH PLATTE RIVER BASIN PROJECT
LOCATION OF
GRAVEL OPERATIONS
DENVER METROPOLITAN AREA
U.S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
DENVER, COLORADO

6a

FIGURE 1



SOUTH PLATTE RIVER BASIN PROJECT

LOCATION OF GRAVEL OPERATIONS
MIDDLE BASIN

U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
DENVER, COLORADO

FIGURE 2

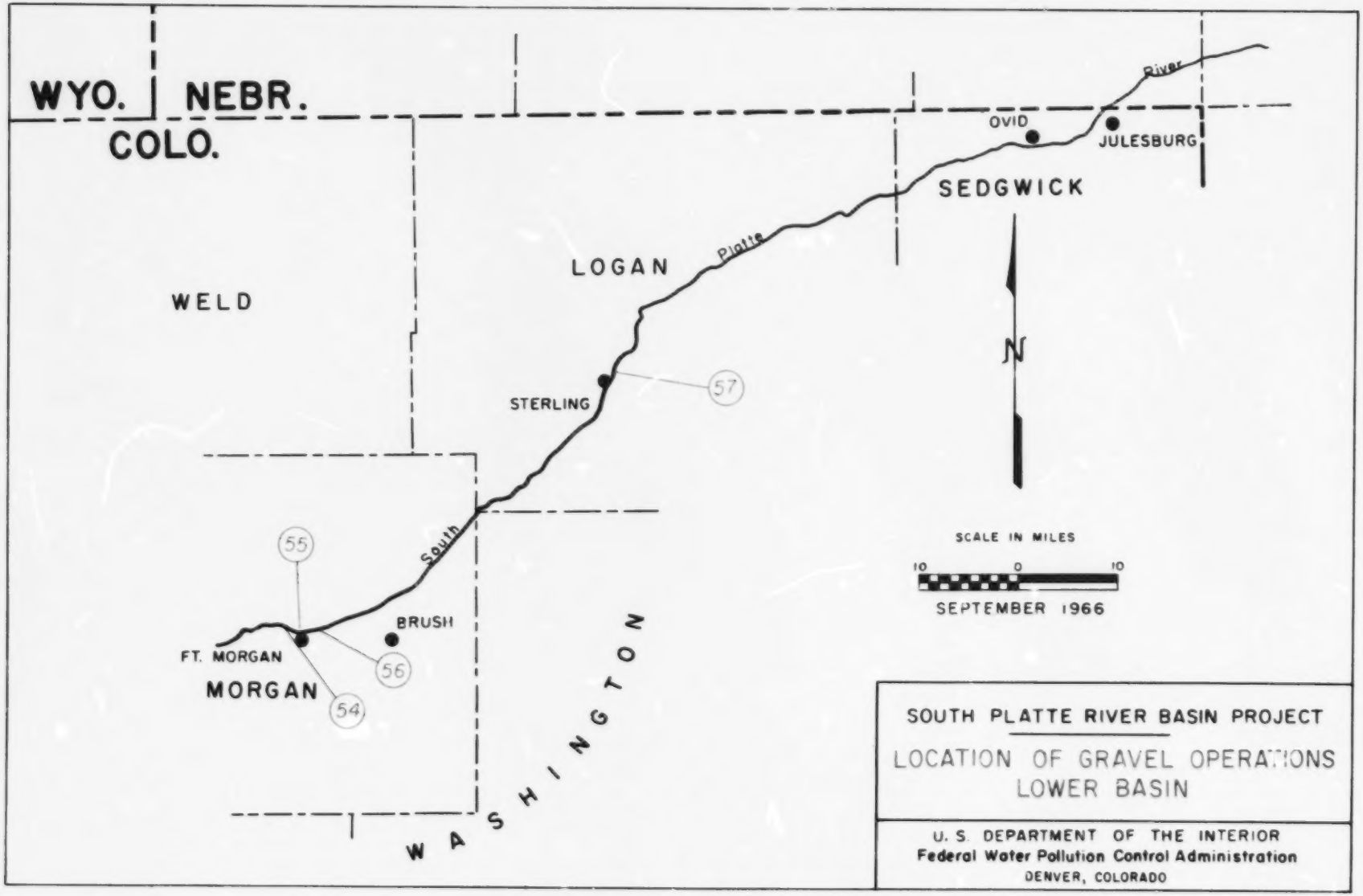

WYO.
NEBR.
COLO.
WELD
LOGAN
SEDGWICK
WASHINGTON
MORGAN
OVID
JULESBURG
STERLING
FT. MORGAN
BRUSH
South Platte River
55
56
57
54
N
SCALE IN MILES
10 0 10
SEPTEMBER 1966
SOUTH PLATTE RIVER BASIN PROJECT
LOCATION OF GRAVEL OPERATIONS
LOWER BASIN
U. S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
DENVER, COLORADO

FIGURE 3

WATER AND WASTE HANDLING - TREATMENT FACILITIES

Available data on type of wash system, if any, amounts of water used in washing and degree of waste treatment provided by each of the 57 gravel and sand operations within the South Platte River Basin are given in Tables III and IV. Table III describes the plants within the Denver Metropolitan Area and Table IV those over the remainder of the Basin. As indicated by Tables III and IV, there are 7 company sites in the Denver Metropolitan Area and 11 such sites over the remainder of the Basin described as dry operations, which in reality are sand quarry pits and/or dredging from the steam bottom areas. Three of the quarry pits were not operating at the time of field visits. It has been previously mentioned that these operations do not provide for washing of the sand and gravel product. Nevertheless, dredging as distinct from quarrying can effect severe change and degradation in a watercourse by lifting large quantities of silt, fines and bottom muds into suspension within the flowing stream.

There are 8 gravel washeries in the Denver Metropolitan Area and 10 other washeries over the remainder of the Basin which have installed closed-circuit wash systems. Process waters are released into ponds or lagoons wherein the solids are settled out. The waters remaining after seepage and evaporation, if any, are returned to the plant for further washing of sand and gravel. There was no apparent waste discharge into the receiving stream from any of the 18 plants with closed-circuit wash systems.

TABLE III

WASTE DISCHARGE INFORMATION FOR SAND AND GRAVEL OPERATIONS
DENVER METROPOLITAN AREA

Map No.	Name	Flow [a] (gpm)	Location	Treatment
1	Colorado Pre-Mix Co.	1500	South Platte River	Settling pond
2	Hall Sand & Gravel Co.	1200	South Platte River	Settling in ditch
3	Cooley Gravel Co.	--	South Platte River	Closed circuit
4	Peter Kiewit Co.	--	South Platte River	No water used
5	Central Construction Co.	--	South Platte River	No water used
6	Bear Valley Gravel Co.	1500	Bear Creek	Settling ponds
7	Morrison Redi-Mix Concrete Co.	1000	Bear Creek	Settling pond
8	Herbertson Sand & Gravel Co.	--	Bear Creek	Closed circuit
9	Winslow Construction Co.	--	South Platte River	No water used
10	Seip Brothers Sand Co.	--	Cherry Creek	Closed circuit
11	Mobile Concrete, Inc.	--	Cherry Creek	No water used
12	Empire Sand & Gravel Co.	300	Sand Creek	No treatment
13	Lester Jones Sand & Gravel Co.	500	Sand Creek	No treatment
14	Superior Sand & Gravel Co.	600	Sand Creek	No treatment

Map No.	Name	Flow (gpm) [a]	Location	Treatment
15	Jones Fine Sand Co.	200	Sand Creek	Settling pond
16	Empire Sand & Gravel Co.	--	Clear Creek	Closed circuit
17	Rio Grande Gravel Co.	900	Clear Creek	Settling pond
18	Jefferson Transit Mix Co.	--	Clear Creek	Closed circuit
19	Arvada Redi-Mix Co.	--	Clear Creek	--
20	Suburban Redi-Mix Co.	--	Clear Creek	Closed circuit
21	Cooley Gravel Co.	--	Clear Creek	Closed circuit
22	Brannan Sand & Gravel Co.(Pit No.10)	--	Clear Creek	--
23	Brannan Sand & Gravel Co. (Pit R)	300	Clear Creek	No treatment
24	Western Paving & Construction Co.	200	Clear Creek	No treatment
25	Hubner Construction Co.	--	Clear Creek	No water used
26	Brannan Sand & Gravel Co. (Pit No. 1)	1380	Clear Creek	No treatment
27	Boise Cascade Gravel Co.	--	South Platte River	Closed circuit
28	Commercial Sand & Gravel Co.	1000	South Platte River	Settling basin
29	Adams Transit-Mix Co.	600	South Platte River	Settling basin

[a] Estimate of flow when washing.

TABLE IV

WASTE DISCHARGE INFORMATION FOR SAND AND GRAVEL OPERATIONS
REMAINDER OF BASIN

Map No.	Name	Flow [a] (gpm)	Location	Treatment
30	Platte Valley Concrete Co.	50	South Platte River	Settling basin
31	Boulder Redi-Mix Co.	--	Boulder Creek	No water used
32	Flatiron Sand & Gravel Co.	--	Boulder Creek	Closed circuit
33	Western Paving Co.	--	Boulder Creek	Closed circuit
34	Martenson Sand & Gravel Co.	--	St. Vrain Creek	No water used
35	Martenson Sand & Gravel Co. (Washing Pit)	--	St. Vrain Creek	Settling basin
36	Flatiron Sand & Gravel Co.	--	St. Vrain Creek	No water used
37	Longmont Redi-Mix Co.	--	St. Vrain Creek	No water used
38	Golden Gravel Co.	--	St. Vrain Creek	Closed circuit
39	Jess Johnson Co.	--	Big Thompson River	No water used
40	Loveland Redi-Mix Co.	200	Big Thompson River	Settling basin
41	Flatiron Materials Co.	--	Big Thompson River	No water used
42	Schaffer Sand & Gravel Co.	--	Big Thompson River	No water used
43	Floyd Haag Sand & Gravel Co.	--	Big Thompson River	No treatment

Map No.	Name	Flow [a] (gpm)	Location	Treatment
44	Flatiron Paving Co.	--	Big Thompson River	No water used
45	Moffat & Son Co.	--	South Platte River	Closed circuit
46	Torrez Sand & Gravel Co.	--	South Platte River	Closed circuit
47	Sterling Sand & Gravel Co.	--	Cache la Poudre River	Closed circuit
48	Fort Collins Redi-Mix Co.	600	Cache la Poudre River	No treatment
49	Flatiron Sand & Gravel Co.	1500	Cache la Poudre River	No treatment
50	Schultz & Lindsay Co.	--	Cache la Poudre River	No water used
51	Flatiron Paving Co.	--	Cache la Poudre River	No water used
52	Greeley Sand & Gravel Co.	--	Cache la Poudre River	Closed circuit
53	Herran & Strong Co.	--	Cache la Poudre River	--
54	(Name Unknown)	--	South Platte River	Closed circuit
55	Builders Aggregate Co.	--	South Platte River	Closed circuit
56	Green Brothers Co.	--	South Platte River	Closed circuit
57	Sterling Redi-Mix Co.	1500	South Platte River	Settling basins

[a] Estimate of flow when washing

Twenty-one sand and gravel washeries were found to discharge waste effluents into the Basin streams. Limited treatment for removal of solids from wash waters prior to final discharge was provided by 12 plants (8 in Denver and 4 in remaining Basin). On the other hand, 9 plants (6 in Denver and 3 in remaining Basin), provided no treatment whatsoever. Limited treatment consisted of solids settling in ponds, lagoons, and in some cases within the outlet ditch. Treatment performance varied considerably from one plant to another in removal of solids.

STREAM SURVEY RESULTS

Special sampling studies were conducted in 1965 and 1966 at four sand and gravel sites to determine the nature of wash effluents and effects of these discharges upon the receiving stream. These investigations were undertaken as follows: 1) the South Platte River above Littleton, Colorado and the waste effluent from the Hall Sand and Gravel Company in August 1966; 2) the waste effluent from the Brannan Sand and Gravel Company - Pit No. 1 and associated washery site near the mouth of Clear Creek in September 1966; 3) the Cache la Poudre River directly below Fort Collins, Colorado and the waste discharge from the Fort Collins Redi-Mix Co. in September 1966; and 4) the Cache la Poudre River in the Greeley, Colorado vicinity and the waste releases from the Greeley Sand and Gravel Company in May 1965.

The Hall Sand and Gravel Company, between Kassler and Plum Creek Confluence

The Hall Sand and Gravel Company, located approximately 7 miles upstream of Littleton, Colorado, extracts sand and gravel from the South Platte River bottoms area and after washing and screening of the product, discharges dirt-laden waste waters into the River. The results of the sampling study of August 9-13, 1966 showed an average waste discharge from the gravel washery of 3.4 cfs containing 920 units turbidity, 320 mg/l total dissolved solids, and 3030 mg/l total suspended solids. Daily suspended solids loads entering the South Platte River varied from 5.3 to 12 tons with an average load of 9.4 tons per day. When there was no washery discharge, the suspended solids content in the stream approximated

12 mg/l above the plant and 23 mg/l below the plant. However, with the gravel washery operating, suspended solids increased from 12 mg/l upstream to 102 mg/l at a point 0.7 miles below the plant. High suspended solids were sustained over the next three miles downstream although the levels were somewhat lower than directly below the plant.

Supplementary study on fish populations in the South Platte River furthermore showed a drastic reduction in fish life below the washery operations compared to above. Based upon upstream findings, there was an 81 percent decrease in number of fish and an 88 percent decrease in weight of fish recorded over the 0.7 miles of stream directly below the sand and gravel plant (9).

Brannan Sand and Gravel Co., Pit No. 1 Operations Near Mouth of Clear Creek

A separate study was undertaken during September 6-8, 1966 at the Brannan Sand and Gravel Co. - Pit No. 1 site to determine the nature of waste discharges into Clear Creek. Summary results showed a plant effluent flow of around 3 cfs containing average waste concentrations as follows: BOD - 4 mg/l, COD - 74 mg/l, total dissolved solids - 4480 mg/l, turbidity - 6100 units, total suspended solids - 7500 mg/l, and settleable solids - 41 ml/l. Waste loads superimposed on Clear Creek (based on an 8-hour daily plant operation) were estimated as 12.5 tons per day of total dissolved solids and 22 tons per day of total suspended solids.

Fort Collins Redi-Mix Co. Downstream of Fort Collins, Colorado

A third study was conducted below Fort Collins, Colorado during September 19-22, 1966 to determine effects of the Fort Collins Redi-Mix Co. untreated waste discharges upon the Cache la Poudre River. Survey results showed a heavy sediment-laden, muddy discharge of 1.3 cfs with average waste concentrations as follows: BOD-29 mg/l, COD - 2420 mg/l, total dissolved solids - 10,400 mg/l, turbidity - 16,000 units, total suspended solids 34,600 mg/l, and settleable solids greater than 110 ml/l. This effluent flow demonstrated extremely high waste content in terms of COD, TDS, turbidity, and suspended and settleable solids. Discharge loads from the Fort Collins Redi-Mix Co. exceeded the respective loads measured at the other three washeries during this study. Waste loads entering the Cache la Poudre River (based on an 8-hour daily plant operation) were estimated as 3 tons COD per day, 12.7 tons per day of total dissolved solids, and 42 tons per day of total suspended solids.

The Cache la Poudre River was sampled a short distance above and below the Fort Collins washery and water quality results were as follows:

Waste Parameter	Directly Above Plant	Directly Below Plant
BOD (mg/l)	11	12
COD (mg/l)	37	76
Color (units)	21	26
Turbidity (units)	/	249
TDS (mg/l)	315	363
TSS (mg/l)	12	641
Setl. Sol. (ml/l)	< 0.1	1.9

The effects of the Fort Collins gravel wash discharges upon the Cache la Poudre River are fairly obvious from the above data. One-mile

downstream of the plant, effects upon the river (data not shown herein) were greatly diminished. In essence, the river below the plant was serving as a large settling basin within which large quantities of suspended solids were collecting.

Greeley Sand and Gravel Co., Greeley, Colorado

The earliest study on sand and gravel operations was carried out in May 1965 on the Cache la Poudre River in the vicinity of the Greeley Sand and Gravel Company. The Greeley plant in May 1965 had limited provisions for removal of solids from the wash effluents but since that time nas installed a closed-circuit wash system with little or no solids entry to the stream. The data given below are representative of previous conditions but also show the situation resulting from a typical gravel washery without proper waste treatment.

Results collected over the period May 11-14, 1965 showed a plant effluent flow of 3 cfs containing 10 mg/l BOD, 95 mg/l COD, 13,050 mg/l total suspended solids, and 138 ml/l settleable solids. Waste loads entering tne lower Cache la Poudre River (based on an 8-hour daily plant operation) were estimated as 0.3 tons COD per day and 35 tons per day of total suspended solids.

The Cache la Poudre River was sampled directly above and below the Greeley washery and water quality results were as follows. The river flow was 29 cfs a short distance upstream of the washery.

Waste Parameter	Directly Above Plant	Directly Below Plant
BOD (mg/l)	7	8
COD (mg/l)	13	21
TSS (mg/l)	18	800
Settl. Sol. (ml/l)	< 0.1	10

Effects of the Greeley washery discharges upon the Cache la Poudre River were indeed severe in May 1965. Large quantities of silt and sediment were deposited on the river bottom below the plant and the receiving waters with about 800 mg/l suspended solids gave the appearance of a body of mud moving downstream into Greeley.

CONCLUSIONS AND RECOMMENDATIONS

1) Pollution abatement measures may be more easily undertaken in the sand and gravel industry than for many other types of waste waters. The wash waters may be directed into available barrow pits or readily-constructed lagoons, and the renovated waters can be reused, or returned to the stream after proper treatment. The industry should be made responsible for restoring the gravel-mined area to a more suitable condition than originally found. Mudpiles, rock heaps, and mosquito-breeding swamp holes frequently left remaining in mined-out areas are encouraged by the spoils system. One operator in the Denver area advocates refilling the excavated areas and ponds with unusable sand, covering with topsoil from the bottom land, and converting the area into agricultural lands. In other areas of the country, cases may be cited whereby planned reclamation following active operation has converted unsightly areas into attractive farms, golf courses, scenic lakes and fishing ponds, fully integrated with the appearance and needs of the surrounding countryside.

2) The six following sand and gravel operations in the Denver Metropolitan Area presently having no treatment for waste discharges, should install adequate waste handling and treatment facilities for eliminating existing stream pollution. Whereas gross suspended solids are the major pollutant, other waste loads also may be important.

a. Empire Sand and Gravel Co. (Sand Creek)
b. Lester Jones Sand and Gravel Co. (Sand Creek)
c. Superior Sand and Gravel Co. (Sand Creek)
d. Brannan Sand and Gravel Co. (Pit R), (Clear Creek)
e. Brannan Sand and Gravel Co. (Pit No. 1), (Clear Creek)
f. Western Paving and Construction Co. (Clear Creek)

3) The three following sand and gravel operations outside the Denver area presently having no treatment for waste discharges should install adequate waste handling and treatment facilities for eliminating existing stream pollution. Whereas gross suspended solids are the major pollutant, other waste loads also may be important.

a. Floyd Haag Sand and Gravel Co. (Big Thompson River)
b. Fort Collins Redi-Mix Co. (Cache la Poudre River)
c. Flatiron Sand and Gravel Co. (Cache la Poudre River)

4) The eight following sand and gravel operations in the Denver Metropolitan Area presently with limited treatment of waste discharges should provide improved or additional waste handling and treatment facilities for eliminating existing stream pollution. Whereas gross suspended solids are the major pollutant, other waste loads also may be important.

a. Colorado Pre-Mix Co. (South Platte River)
b. Hall and Gravel Co. (South Platte River)
c. Bear Valley Gravel Co. (Bear Creek)
d. Morrison Redi-Mix Concrete Co. (Bear Creek)
e. Jones Fine Sand Co. (Sand Creek)
f. Rio Grande Gravel Co. (Clear Creek)
g. Commercial Sand and Gravel Co. (South Platte River)
h. Adams Transit Mix Co. (South Platte River)

5) The four following sand and gravel operations outside the Denver area, presently with limited treatment of waste discharges, should provide improved or additional waste handling and treatment facilities for eliminating existing stream pollution. Whereas gross suspended solids are the major pollutant, other waste loads also may be important.

a. Platte Valley Concrete Co. (South Platte River)
b. Martenson Sand and Gravel Co. (Washing Pit), (St. Vrain Creek)
c. Loveland Redi-Mix Co. (Big Thompson River)
d. Sterling Redi-Mix Co. (South Platte River)

6) Sand and gravel operations as may not be listed in this report and having waste discharges containing excessive suspended solids and other deleterious materials, should provide adequate treatment of any such effluent into a Basin stream with the objective of eliminating existing stream pollution.

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